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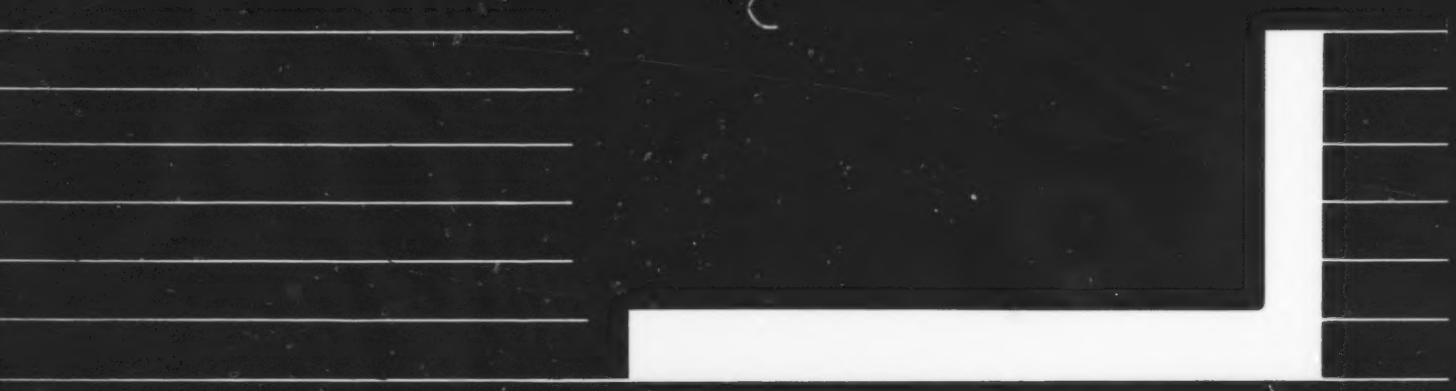
Canadian Aviation Safety Board



Rapport d'un fait aéronautique civil

Civil Aviation Occurrence Report

Canada

The Canadian Aviation Safety Board investigated this occurrence for the purpose of advancing aviation safety. It is not the object of the Board to determine or apportion any blame or liability.

AVIATION OCCURRENCE REPORT

WESTERN AIRLINES INC.
BOEING 727-247 N2819W
CALGARY INTERNATIONAL AIRPORT,
ALBERTA
13 MARCH 1987

REPORT NUMBER 87-W70901

SYNOPSIS

The aircraft was on a scheduled night flight to Calgary, Alberta from Los Angeles, California. During two successive approaches at Calgary International Airport, the captain experienced difficulty visually acquiring the runway environment as the aircraft was about to land. A go-around was initiated after the first approach, but the aircraft touched down hard before climbing away in a missed approach. On the second approach, the first officer took over control and landed the aircraft. The aircraft's right wing tip struck the runway during one of the two approaches, probably during the first.

The Canadian Aviation Safety Board was unable to determine why the captain experienced difficulty visually acquiring the runway environment. He did not immediately initiate a go-around and did not advise the first officer of his difficulty. The aircraft was manoeuvred at a low altitude over the runway during the first approach.

Ce rapport est également disponible en français.

23 June 1989

TABLE OF CONTENTS

		Page
1.0	**FACTUAL INFORMATION**	1
1.1	History of the Flight	1
1.2	Injuries to Persons	2
1.3	Damage to Aircraft	2
1.4	Other Damage	2
1.5	Personnel Information	3
1.6	Aircraft Information	3
1.7	Meteorological Information	4
1.8	Aids to Navigation	4
1.9	Communications	5
1.10	Aerodrome Information	5
1.11	Flight Recorders	6
1.11.1	Cockpit Voice Recorder	6
1.11.2	Flight Data Recorder	6
1.12	Wreckage and Impact Information	7
1.13	Medical Information	7
1.13.1	Captain's Use of Reading Glasses	8
1.14	Fire	8
1.15	Survival Aspects	8
1.16	Tests and Research	8
1.16.1	Flight Simulator Approaches	8
1.17	Additional Information	9
1.17.1	Flight Crew Actions	9
1.17.2	Leading Edge Device In-Transit Lights	10
2.0	**ANALYSIS**	11
2.1	Introduction	11
2.2	Weather	11
2.3	Human Factors	11
2.3.1	Reduction in Visual Landing Environment Cues	11
2.3.2	Flight Crew Interaction and Communication	12
2.3.3	First Officer Intervention During Second Landing Attempt	13
2.4	Aircraft Damage Analysis	13
2.5	Flight Recorder Analysis	14
3.0	**CONCLUSIONS**	15
3.1	Findings	15
3.2	Causes	16
4.0	**SAFETY ACTION**	17
4.1	Safety Concerns	17
4.1.1	Cockpit Resource Management	17
4.1.2	Cockpit Voice Recorder	17
5.0	**APPENDICES**	
	APPENDIX A - GLOSSARY	A-1

1.0 FACTUAL INFORMATION

1.1 History of the Flight

Western Airlines Inc., Flight 796, a Boeing 727-247, registration N2819W, was operating on a scheduled flight from Los Angeles, California to Calgary, Alberta. Flight 796 departed Los Angeles 13 March 1987 at 2030 mountain standard time (MST)*. On board were 104 passengers and a crew of seven.

The flight to Calgary was routine. Prior to the approach, the Calgary weather, recorded at 2300 MST, was a 200-foot** ceiling with visibility three-quarters of a mile in fog. Visibility to the north was reported as three-eighths of a mile, with a runway visual range (RVR)*** of 3,500 feet. Flight 796 was given vectors for an instrument landing system (ILS) approach to runway 16. The captain flew the aircraft manually, and the flight crew reported that the localizer and glide slope were centered throughout the approach. The first officer made the mandatory altitude call-outs down to decision height, reporting when the approach lights were visible at 100 feet above decision height and when the landing environment was sighted at decision height. As the approach continued over the approach lights, the first officer called out radar altimeter heights at 50-foot increments above the runway elevation.

As the aircraft crossed over the end of the high-intensity approach lights, the captain later stated that he did not see the runway lights for one or two seconds and then found that he could see only three or four lights on the left side of the runway, and these he could not see clearly. The captain made no comment to the other crew members at the time and continued the approach to the landing flare, when the first officer told the captain that the aircraft was veering off the left side of the runway. A go-around was commenced, but the aircraft touched down heavily before climbing away. There were no system abnormalities noted by the flight crew after the missed approach, other than the second officer recalling that a leading edge device in-transit light remained illuminated after the flaps were retracted.

* All times are MST (Coordinated Universal Time (UTC) minus seven hours) unless otherwise stated.
** Units are consistent with official manuals, documents, reports, and instructions used by or issued to the crew.
*** See Glossary for all abbreviations and acronyms.

The captain manually flew the second approach, and the flight crew reported that the localizer and glide slope were again centered throughout the approach. The approach lights were again sighted 100 feet above decision height, and, once more, the captain had difficulty visually acquiring the runway environment as the aircraft crossed over the approach lights. The first officer did not lose visual contact with the runway, and the captain did not comment on the difficulty he was experiencing. As the captain was about to flare the aircraft for landing, the first officer felt that the aircraft was not going to land safely on the runway and offered to take over the landing. The first officer realigned the aircraft with the runway and completed the landing. The second officer made no comment during either landing attempt regarding the attitude or position of the aircraft. The captain taxied the aircraft to the terminal where passengers disembarked and the aircraft was shut down. The flight crew was subsequently informed that the right wing tip of the aircraft was damaged.

The accident occurred at 2313 MST during the hours of darkness, on runway 16 at the Calgary International Airport, at lat 51°07'N, long 114°01'W at a field elevation of 3,556 feet, above sea level (asl).

1.2 Injuries to Persons

	Crew	Passengers	Other	Total
Fatal	-	-	-	-
Serious	-	-	-	-
Minor/None	7	104	-	111
Total	7	104	-	111

1.3 Damage to Aircraft

The aircraft was substantially damaged.

1.4 Other Damage

There was no other damage.

1.5 Personnel Information

	Captain	First Officer	Second Officer
Age	51	40	38
Pilot Licence	Airline Transport	Airline Transport	Flight Engineer
Medical Expiry Date	Valid	Valid	Valid
Total Flying Time	13,500 hr	7,700 hr	7,000 hr
Total on Type	2,500 hr	1,040 hr	576 hr
Total Last 90 Days	182 hr	204 hr	200 hr
Total on Type Last 90 Days	182 hr	204 hr	200 hr
Hours on Duty Prior to Occurrence	5 hr	5 hr	5 hr
Hours off Duty Prior to Work Period	48 hr	34 hr	48 hr

All the flight crew members were trained and qualified to conduct the flight. The captain occupied the left-hand seat and was the pilot flying. He had 31 years aviation experience and had held captain status since 1976. He held a valid medical with the limitation that glasses be available. The first officer had 21 years aviation experience, including two years experience as first officer on Boeing 727 aircraft. He held a valid medical with no limitations. The second officer had been hired by Western Airlines eight months prior to the accident and had no prior air carrier experience. He held a valid medical with no limitations.

1.6 Aircraft Information

Manufacturer	Boeing Commercial Airplane Co.
Type	727-247
Year of Manufacturer	1975
Serial Number	12057
Certificate of Airworthiness	Valid
Total Airframe Time	37,000 hr
Engine Type (3)	Pratt & Whitney JT8D-15
Maximum Allowable Take-off Weight	190,500 lb
Recommended Fuel Type	Jet A

The aircraft landing weight prior to the first approach was calculated by the crew to be 145,300 pounds. The reference landing speed was set at 130 knots using 30 degrees of flap.

The aircraft was certified, equipped, and maintained in accordance with existing regulations and approved procedures. The weight and centre of gravity were within the prescribed limits.

1.7 Meteorological Information

A maritime trowal moving northeastward across southern Alberta covered the area with low cloud and fog. During the four-hour period prior to the occurrence, the Calgary International Airport experienced ceilings lowering from 900 to 200 feet, and visibilities from 10 miles to one-quarter mile in fog.

At 2010 MST, prior to the departure of Flight 796 from Los Angeles, the crew received a weather forecast for Calgary. The forecast, which was issued at 1544 MST and valid for the period 13 March at 1600 MST to 14 March at 1600 MST, predicted that by 2000 MST the following conditions would exist:

> 500-foot ceiling, sky obscured, visibility three miles in fog; occasional 300-foot ceiling, sky obscured, visibility one mile in light snow and fog.

The actual weather reported at Calgary at the time Flight 796 departed Los Angeles was a measured 700-foot broken cloud layer and a 1,000-foot overcast condition with a visibility of 10 miles. The surface wind was 140 degrees at five knots.

When Flight 796 was 35 miles south of Calgary, Arrival Control passed the last special report as follows:

> "Indefinite ceiling, 300 obscured, one mile in fog, visibility north and east one-half mile, RVR setting five, runway sixteen, 3,500 feet."

The last RVR reported to the pilot during the first approach was 4,000 feet and 2,800 feet during the second approach. As the aircraft taxied clear of the runway, the RVR was back up to 3,500 feet.

1.8 Aids to Navigation

As a result of this occurrence, a special flight inspection was carried out on the runway 16 ILS localizer on 16 March 1987. This inspection showed that the facility was operating within established tolerances and that there was no significant change from the results

of the last routine inspection carried out on 15 January 1987. A monitor system in the tower and in the terminal confirmed that the ILS was operational throughout the evening of 13/14 March 1987. Pilots of aircraft arriving at Calgary immediately before and after the Western Flight 796 occurrence reported the ILS to be operating normally. Minima for an ILS approach to runway 16, as published in the Canada Air Pilot, are a 200-foot ceiling, one-half mile visibility, and an RVR of 2,600 feet. Western Airlines approach minima for Calgary runway 16 were the same as those published in the Canada Air Pilot.

1.9 Communications

Communication between Western 796 and Calgary Arrival was established at 2252 MST when the aircraft was 35 miles south of the airport. Flight 796 was given descent clearance and vectors for runway 16 as well as Calgary weather and runway conditions. At 2308 MST, Flight 796 was cleared for the approach and then switched to tower frequency. Flight 796 was given traffic information and, at 2312 MST, clearance to land. Flight 796 asked if the approach lights were full up, and tower responded that the approach lights were on strength five and that the RVR was 4,000 feet. At 2314 MST, Flight 796 reported going around and climbing away for another approach.

Flight 796 was vectored by arrival control at 7,000 feet for a right-hand circuit for another approach to runway 16. At 2323 MST, an RVR of 3,500 feet was passed to Flight 796, but, one minute later, the tower passed an RVR of 2,800 feet to a Pacific Western flight on the approach ahead of Flight 796. At 2326 MST, the tower passed an RVR of 2,800 feet to Flight 796, and the flight was cleared to land at 2327 MST. At 2330 MST, Flight 796 was cleared off the runway to the terminal building.

1.10 Aerodrome Information

Calgary International Airport is licensed as a public airport operated by Transport Canada. It is located in the northeast corner of the City of Calgary at lat 51°07'N, long 114°01'W at a reference elevation of 3,557 feet. The runway in use was runway 16, which is asphalt, 12,675 feet long by 200 feet wide, and has flashing strobe lights as runway identification lights. It also has a two-bar visual approach slope indicator system (VASIS) that was not switched on at the time of the occurrence because the weather was below visual meteorological conditions (VMC). Runway 16 has

high-intensity runway edge lights, threshold lights, and runway end lights. The runway lights were on setting five, the maximum for the system.

Runway 16 is equipped with a Centre Row Category I High-Intensity Approach Lighting System. This system includes 30 centre line barrettes of five lights each, the barrettes are 100 feet apart, giving a total length of the system of 3,000 feet out from the end of the runway. One horizontal bar, 70 feet long, is situated 200 feet from the end of the runway, and a second horizontal bar, 130 feet long, is located 1,000 feet from the end of the runway. The approach lights were on setting five at the time of the accident, the maximum setting for the system. Of the 232 lights in the approach lighting system, only three were not functional when the system was inspected following the accident. No repair or replacement had been done to the system between the time of the accident and the inspection.

1.11 Flight Recorders

The cockpit voice recorder (CVR) and the flight data recorder (FDR) were removed from the aircraft after the occurrence and transported to the National Research Council Flight Recorder Playback Centre for analysis.

1.11.1 Cockpit Voice Recorder

The aircraft was equipped with a Fairchild A100 CVR, serial number 2457. In this aircraft, the CVR operates automatically whenever electrical power is provided. Previously recorded information is automatically erased and recorded over after the CVR 30-minute audio-tape has completed one continuous loop. No usable information was obtained from the CVR as the aircraft was powered electrically for a significant period of time after the occurrence. The flight crew did not pull the CVR circuit-breaker to protect previously recorded information when they became aware on the ground that the aircraft had been involved in a reportable occurrence.

1.11.2 Flight Data Recorder

The aircraft was equipped with a Sundstrand Universal FDR, serial number 280. This is a five-parameter digital FDR that records 25 hours of data on alternating odd and even tracks. Data concerning the occurrence were recorded on track number six and included large losses in bit synchronization. Data editing allowed restoration of the data bit-stream and resulted in recovery of incident data. The five recorded parameters included two for pressure altitude (one fine and one coarse) plus one each for indicated airspeed, magnetic heading, and vertical acceleration.

1.12 Wreckage and Impact Information

The damage to the right wing tip due to ground contact was examined by the carrier's maintenance personnel who indicated that the number eight leading edge slat, the number seven leading edge slat outboard corner, the right outboard flap trailing edge, the number eight leading edge slat actuator and fairing, plus the outer wing tip fairing had been damaged and required replacement or repair. In addition, web and stringer damage was evident in the area of the wing tip.

An examination of the aircraft damage and the runway was made to determine when the wing tip strike occurred. The evidence of flap track witness marks, distortion of screwjacks, and other damage did not determine whether the wing tip struck the runway during the first or second landing attempt. The runway was swept and sanded after the aircraft had landed and before CASB investigators inspected it.

1.13 Medical Information

At the time of the occurrence, the flight crew held valid United States Federal Aviation Administration (FAA) First Class medical certificates. The captain's medical certificate contained the following limitations: "Holder must possess lenses that correct for near vision while exercising the privileges of his airman certificate." The captain had been tested by his personal opthalmologist several years prior to the occurrence to determine whether reading glasses were required. This and subsequent eye examinations indicated a need for near vision correction, commencing with 1.25 magnification reading glasses. At the time of the occurrence, the captain had 2.75 magnification reading glasses available.

The first and second officer's medical certificates did not contain any limitations.

Additional medical information concerning the captain was sought from both the captain and from the company, but both declined as was their right under American law.

Recent flight crew activity was discussed with each pilot, and there was no indication of any unusual work or social pattern that would have produced significant levels of fatigue.

1.13.1 Captain's Use of Reading Glasses

The captain's reading glasses were of the "half-eye" variety that are designed to allow the wearer to look over the top of the lenses for other than near vision requirements. It was the captain's practice to wear his reading glasses during day and night instrument approaches and visual approaches at night. He stated that he would take the glasses off upon reaching approach minima when he transferred his visual scan to the runway. He would then place the glasses on the instrument panel glare shield prior to landing. If the captain felt there was insufficient time to take the reading glasses off prior to landing, he would look over the glasses and carry out a landing. He had not removed his glasses for either landing attempt at Calgary.

1.14 Fire

There was no evidence of fire either before or after the occurrence.

1.15 Survival Aspects

Not pertinent.

1.16 Tests and Research

1.16.1 Flight Simulator Approaches

Some months after the occurrence, the captain surmised that improper use of half-eye reading glasses may have contributed to the vision difficulty that he had experienced. A Delta Air Lines Boeing 727 flight simulator was used to determine what effect the improper use of half-eye reading glasses might have on the captain's ability to land the aircraft safely. Two simulated night instrument approaches were flown using the glasses, with the occurrence pilot looking over the glasses for the actual landings. The captain experienced no difficulty landing the aircraft on the centre line. A third approach was flown with the glasses worn higher on the nose, where the captain would find himself looking through the glasses for the landing attempt. As the aircraft crossed the runway end lights, he had difficulty landing the aircraft.

1.17 Additional Information

1.17.1 Flight Crew Actions

On the two successive approaches, just before landing, the aircraft was not properly aligned with the runway. During these landing attempts, the captain and the first officer received different landing environment visual cues after the aircraft crossed the end of the high-intensity approach lights. No comment was offered by the captain regarding the perceived reduction in visibility. The first officer did not lose visual contact with the runway; however, he did note that the aircraft turned toward the left side of the runway at an angle of approximately 10 to 20 degrees to the left of the runway heading, immediately after crossing the end of the high-intensity approach lights. The second officer's recollection of both landing attempts is less specific than those of the captain and the first officer; however, he did note that his visual cues of the runway were reduced as the aircraft nose was raised during both landing flares.

During the interval of approximately seven seconds between the aircraft crossing the end of the approach lights and the hard landing on the first approach, the first officer called out radar altitudes above the runway, as well as relative alignment of the aircraft to the runway. None of the flight crew could recollect the exact words or actions of the first officer that prompted the go-around and missed approach. After the aircraft touched down hard during the go-around, the missed approach was uneventful, other than the second officer recalling a brief illumination of the leading edge device in-transit light after the flaps had been retracted.

Before starting the second approach, the flight crew did not discuss what had happened during the first approach, other than the captain stating that he did not have the full runway in sight and the first officer commenting that he had maintained visual contact with the runway from the time the aircraft had descended through decision height. The second officer did not offer any comment regarding the approach, hard landing, or go-around.

The captain considered using the autopilot to fly a fully coupled approach on the second attempt. He also considered transferring control to the first officer, as the first officer had apparently maintained visual contact with the runway throughout the first landing attempt. After considering these two options, but not discussing them with the other crew members, the captain decided that he would manually fly the second approach.

The first officer also considered these two options, mentioning them to the captain. He assumed that the lack of response by the captain meant that the captain had considered these options and rejected them. The captain then stated his intention to again manually fly the approach and landing; this did not prompt discussion by any of the flight crew.

The second approach proceeded normally, and the aircraft was stabilized on the localizer and glide slope at decision height. The captain's loss of visual landing cues as the aircraft again passed over the end of the approach lights did not result in comment or action by the captain. The first officer again called out radar altitudes above the runway and that the aircraft was drifting to the left. Believing that the captain could not land the aircraft safely, the first officer offered to take over control, and he then landed the aircraft.

Western Airlines, like all large air carriers, trained its flight crews to operate as teams where individuals had clearly defined responsibilities that were understood by all other flight crew. Whenever an abnormal situation became evident, flight crews were trained to immediately and clearly identify the abnormality so that appropriate corrective could be taken. First and second officers were expected to advise captains whenever the aircraft was not operating, or being operated, normally. Captains were expected to immediately advise the other flight crew whenever an abnormality became evident and to direct corrective action. This process is recognized by operators of multicrew aircraft as being the best method of ensuring the most immediate and coordinated response by flight crews to an abnormal situation.

1.17.2 Leading Edge Device In-Transit Lights

The B727 employs leading edge devices that extend fully whenever trailing edge flaps are extended two degrees or more. Leading edge device in-transit lights are located on the co-pilot's instrument panel to the immediate left of the landing gear selector handle. In addition, in-transit lights are also located on the second officer's panel. The leading edge device in-transit lights illuminate from the time the leading edge devices are commanded to extend or retract until this position is reached.

2.0 ANALYSIS

2.1 Introduction

The investigation did not reveal any aircraft equipment malfunction, nor any instrument landing system or airport lighting discrepancies that would have contributed to the occurrence. The analysis focuses on the captain's difficulty acquiring visual contact with the runway environment, flight crew interaction and communication, aircraft damage, and the limited information available from the flight recorders.

2.2 Weather

Weather conditions remained near, but not below minima, during the period Flight 796 was attempting to land at Calgary. Although the weather office reported a visibility of one-quarter of a mile, two miles from the touchdown area of runway 16, the RVR did not go below 2,800 feet. The pilots of aircraft landing immediately prior to and after Flight 796 reported that the weather conditions were better than minimums and that they were able to land without incident.

2.3 Human Factors

2.3.1. Reduction in Visual Landing Environment Cues

Some months after the occurrence, the captain surmised that use of half-eye reading glasses may have contributed to the vision difficulty that he had experienced. The captain theorized that he may have inadvertently looked through his reading glasses, rather than over them, when the last approach lights passed under the aircraft. Looking through reading glasses would significantly reduce distant visual cues and would result in the visual distortion the pilot experienced. The captain's normal practice was to remove his glasses prior to landing. On these two approaches he did not, presumably because the weather conditions did not allow sufficient time to do so. Given that he had less experience landing with his glasses on, it is possible that he inadvertently looked through his glasses during the landing phase and had difficulty acquiring visual contact with the landing environment.

Consideration was given to the possibility that the captain may have thought that he had sufficient runway lights to provide adequate landing cues while he still had the brighter and more numerous approach lights in

view. When the end of the approach lights passed under and out of the captain's view, he may have interpreted the few visual landing cues remaining (three to four left runway edge lights) as a sudden reduction in visibility. It is possible that the aircraft's left-wing-down attitude near the runway may have obscured the captain's view of the right-hand runway lights; however, he would have been looking ahead as well as using his peripheral vision to align the aircraft with the runway. His forward visual cues would not have been affected by the attitude of the aircraft about the longitudinal axis. Therefore, this possibility was discounted.

The possibility that the captain had mistaken the runway edge lights for runway centre line lights was also considered. Such a mistake could explain why the aircraft moved from the runway centre line to the left edge of the runway immediately prior to both landing attempts. However, the captain had flown into Calgary numerous times before at night and should have been aware that runway 16 did not have centre line lighting. Furthermore, his initial, recurrent, and upgrade simulator training included low visibility and night approaches and landings on runways with and without centre line lighting; he therefore should have been able to differentiate between edge and centre line runway lights. Given the above and his extensive flying background in landing on runways with or without centre line lighting, it is unlikely that the captain mistook the runway edge lights for runway centre line lighting.

2.3.2 Flight Crew Interaction and Communication

The transfer of information between the first officer and the captain on the first approach was good, up until the time the captain experienced difficulty visually acquiring the runway environment. When the captain experienced this difficulty at a low altitude, he took no immediate corrective action, nor did he communicate to the first and second officers what he had experienced. The first officer did not lose visual contact with the runway and had no reason to believe that the captain was experiencing difficulty. The first officer called out radar altitudes and relative drift angles when the aircraft was close to the ground, but the late go-around and hard touchdown, followed by the missed approach, did not prompt any meaningful discussion among the flight crew about what had occurred, why it had happened, and how it could be avoided during the next approach. Each flight crew member had his own thoughts regarding these matters but did not discuss them with the others. As a result, the second approach was a repetition of the first, up to the point where the first officer assumed control and landed the aircraft.

It could not be determined why these three individuals reacted as they did in these circumstances. However, there is an aviation industry recognized means of reducing the possibility of such breakdowns in flight crew communication and decision-making. For a number of years, various airlines, air forces, and aviation departments have been training their pilots to become better decision-makers by increasing their awareness of what has come to be known as cockpit resource management (CRM). Pilots are exposed to various situations, both in classrooms and simulators, that require the best cooperative effort of all the flight crew to ensure that the most appropriate action is taken in as timely a manner as possible. On a recurrent basis, some air carriers also utilize Line Oriented Flight Training (LOFT) in simulators to reinforce the decision-making and communication skills that have been taught previously. Western Airlines Inc., now part of Delta Air Lines Inc., did not have such a program at the time of this occurrence. It is understood that Delta is in the process of developing a flight crew decision-making and communication program similar to that outlined above.

2.3.3 First Officer Intervention During Second Landing Attempt

The captain and the first officer have similar recollections of when and how the first officer took control and landed the aircraft on the second landing attempt. The first officer recognized that, if the captain continued the landing attempt, the aircraft was going to touch down either improperly aligned with the runway or off the runway. The first officer believed he had sufficient visual cues to land the aircraft safely and then offered to do so. Whether the captain was deemed to be incapacitated by the first officer or whether the captain felt incapacitated could not be reliably determined. The second officer only recalls the first officer offering to land the aircraft and then doing so.

2.4 Aircraft Damage Analysis

Based on the analysis of the FDR data and the second officer's recollection of a leading edge device in-transit light being illuminated after the missed approach, it was concluded that the wing-tip strike probably occurred on the first landing attempt. Given the abrupt heading change from left to right immediately after the hard touchdown, it would appear that the aircraft was in a right-wing-low attitude at the time of touchdown. The flight crew recalled that the nose of the aircraft had been raised to a go-around attitude prior to the touchdown. A right-wing-low and positive pitch

attitude could reduce wing-tip-to-runway clearance to nil, and thus cause a wing-tip strike. Exactly what the bank angle and pitch attitude would have been at impact could not be precisely determined as the FDR did not record aircraft bank and pitch values.

The second officer's recollection of a leading edge device in-transit light being illuminated, after the trailing flaps were retracted on the missed approach, gave the best indication of when the wing-tip strike occurred. The right wing leading edge devices were damaged during the wing-tip strike and, as a result, could not be retracted. Retraction of trailing edge flap would have resulted in illumination of a leading edge device in-transit light, signifying that leading edge devices were not retracted as commanded by the trailing edge flaps. Extension of the trailing edge flaps prior to the second approach would have extinguished the in-transit light as the damaged leading edge devices would have been extended as commanded by the trailing edge flaps.

2.5 Flight Recorder Analysis

The five-parameter FDR installed on this aircraft did not provide sufficient information to accurately determine aircraft attitude. Had this aircraft been a Canadian-registered aircraft, it would have been required to have an FDR capable of recording nine specific additional parameters, including flight control inputs. This flight control information would have assisted in analysing the sequence of events immediately before the wing-tip strike occurred.

The crew was aware that both final approaches and the landing were not normal. After the passengers had deplaned, the crew was informed that the right wing tip had been damaged. Given this information, it is unfortunate that the captain did not ensure that information on the CVR was preserved.

3.0 CONCLUSIONS

3.1 Findings

1. During an approach in reduced visibility, the captain, who was the pilot flying, experienced difficulty visually acquiring the runway environment after the aircraft passed over the high-intensity centre line approach lights.

2. The captain was wearing half-eye reading glasses for the approach and landing attempts, and it is possible that the improper use of the glasses contributed to the vision difficulty experienced by the captain.

3. The captain did not inform the other flight crew that he was experiencing difficulty.

4. The captain did not immediately initiate a go-around when he experienced difficulty.

5. The first officer maintained visual contact with the landing environment and informed the captain that the aircraft was diverging from the runway centre line.

6. A go-around was initiated after the first approach and prior to landing, but the aircraft touched down heavily before continuing in a missed approach.

7. Before commencing the second approach, there was no discussion and analysis by the flight crew as to why the first landing attempt was unsuccessful and what could be done to better ensure a successful landing on the next approach.

8. During the second approach, the captain again experienced difficulty visually acquiring the runway environment after passing over the approach lights.

9. On the second approach, the first officer maintained visual contact with the landing environment, observed that the aircraft was diverging from the runway centre line, took control of the aircraft, and carried out the landing.

10. It was concluded that the wing tip, outboard leading edge slat, outboard trailing edge flap, and aileron on the right wing were probably damaged during the first touchdown.

11. The limited data provided by the five-parameter digital FDR did not allow an adequate analysis of the sequence of events leading to the wing-tip strike.

12. The recorded information on the CVR was not preserved after completion of the flight, as is required by Canadian regulations for an aircraft involved in an accident.

13. The loss of CVR information severely hampered the complete and accurate determination of the flight crew's actions during both landing attempts.

14. The flight crew was certified and qualified for the flight in accordance with existing regulations.

15. The aircraft was certified, equipped, and maintained in accordance with existing U.S. regulations and approved procedures.

16. The weight and centre of gravity were within the prescribed limits.

3.2 Causes

The Board was unable to determine why the captain experienced difficulty visually acquiring the runway environment. He did not immediately initiate a go-around and did not advise the first officer of his difficulty. The aircraft was manoeuvred at a low altitude over the runway during the first approach.

4.0 SAFETY ACTION

4.1 Safety Concerns

4.1.1 Cockpit Resource Management

This accident underlines the need for flight crews to coordinate and communicate with each other in the analysis of problems encountered during flight operations. During both approaches, the lack of communication among the pilots permitted the development of a hazardous situation that could have been avoided. Increasingly, the aviation community is recognizing the need for formal training for flight crews to enhance their understanding and skills in interpersonal communications, crew coordination, and the management of all available resources in the cockpit for coping with unforeseen situations. As early as 1979, following an accident involving a DC-8 which ran out of fuel during preparation for an emergency landing, the National Transportation Safety Board (NTSB) recommended that all air carriers indoctrinate their crew members in the principles of flight deck resource management, "with particular emphasis on the merits of participative management for captains and assertiveness training for the cockpit crew members." Since that time, a diversity of training programs for cockpit resource management have been adopted by many of the major airlines.

The Board does not, at this time, propose the mandatory incorporation of cockpit resource management into flight crew training. Instead, it encourages the individual air carriers to adopt CRM training when appropriate for their level and type of operation.

4.1.2 Cockpit Voice Recorder

The Board is concerned that valuable evidence was erased from a serviceable CVR when aircraft electrical power was left turned on and the CVR circuit-breaker was not pulled to preserve that evidence. On 18 November 1987, the Board issued a Statement of Operational Requirements (SOR) to the Deputy Minister of Transport Canada that outlined the benefits of capturing evidence on cockpit voice recorders to identify the cause of aviation occurrences. In this accident, had this valuable information concerning human performance and cockpit crew communication been available, the Board may have been able to identify pertinent safety deficiencies.

Both the FAA in the United States and the Civil Aviation Authority (CAA) in Britain are considering improvements to CVR capabilities. Most recently, an incident in April 1988 at Gatwick led to recommendations by the Air

Accidents Investigation Branch of the UK that a CVR capable of retaining two hours of recording be developed and, when available, that it be made mandatory for aircraft over 5 700 kilograms.

The CASB will also continue to seek changes to Air Navigation Order, Series II, Numbers 13 and 14 that will result in the more effective capture of CVR/FDR data for flight safety purposes.

This report and the safety action therein has been adopted by the Chairman, K.J. Thorneycroft, and Board Members:

N. Bobbitt
L. Filotas
A. Portelance
B. Pultz
R. Stevenson
F. Thurston

GLOSSARY

asl	above sea level
CAA	Civil Aviation Authority
CASB	Canadian Aviation Safety Board
CRM	cockpit resource management
CVR	cockpit voice recorder
FAA	Federal Aviation Administration
FDR	flight data recorder
hr	hour(s)
ILS	instrument landing system
lat	latitude
lb	pound(s)
LOFT	Line Oriented Flight Training
long	longitude
MST	mountain standard time
N	north
NTSB	National Transportation Safety Board
SOR	Statement of Operational Requirements
RVR	runway visual range
UTC	Coordinated Universal Time
VASIS	visual approach slope indicator system
VMC	visual meteorological conditions
W	west
°	degree(s)
'	minute(s)